From: Randy Norian <rg500delta@mac.com>
Subject: **great synopsis of coolant discussions**
Date: June 28, 2003 1:35:05 PM CDT
To: gammalist Maillist <gammalist@edj.net>

whew, I found a site where he has collected a lot of cooling system info in one place.

here's the cut and paste-

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YAMAHA VMAX and FZ1
Coolant opinions for Motorcycles

A few note clips from riders of the Max, V65, FZ1, and other Fast Bikes, plus basic coolant articles, with the intent of giving a little information to begin your research into the type of coolant you want to run and how you want to maintain your cycle's cooling system.

The general trends seem to be:
1. Use good quality ethylene glycol coolant, but study the "orange stuff" controversy carefully.
2. Complete flushing and replacing coolant every year is mandatory to avoid chemical changes toward the acidic range.
3. Use a 50-50 mixture of coolant and distilled, then soft water but never tap water.
4. Red Line Water Wetter has no significant function when used with a 50-50 mixture.
5. Installation of a manual fan switch gives the best control of the fan in hot weather.
THE FINAL WORD IS 50-50 RATIO AND CHANGE EVERY YEAR.

[] VMAX SITEMAP **[]** VMAX, THREE MUSCLE BIKE **[]** ZMAX & OPINIONS **[]** HONDA V65 MAGNA **[]** V65 MODS AND OPINIONS **[]** MAIN IOWAZ SITEMAP **[]** YAMAHA FZ1 SITEMAP **[]** latest upload: 7/30/2002

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Intro: Coolant discussions become about as lively on most of the cycle lists as the oil threads. Below are clips from various articles and posts regarding the coolant issue which have been collected since the mid 1990's. They come from various levels of scientific-objective-thinking to more shoot-from-the-hip subjective ideas. The intent is to help give someone coming into the cycling world a jump-off point to making their own investigation and decision into the coolant issues. I have done a lot of pondering/listening/learning on the coolant and lubrications issues since the internet became more and more functional in the mid '90's, plus have done a few full circles in thinking in some areas, while continuing on the decision merry-go-round. I post/edit to the coolant topic with only basic mechanical experience, but with scientific training/knowledge base. If anyone has info/additions they would like pasted into this page or find corrections or desire deletions please post them for consideration for inclusion into the notes for others' benefit.

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www.prestone.com

Prestone advertises----

Prestone Antifreeze/Coolant Ingredients (greenish color)-- Ethylene Glycol (107-21-1), Diethylene Glycol (111-46-6, water (7732-18-5) and proprietary corrosion inhibitors. Color Greenish. What separates Prestone from some other antifreezes is how well it protects against rust and corrosion that can accumulate in your cooling system and cause problems like radiator leaks, clogged thermostats and damaged water pumps. Contains an anti-corrosion chemical system which bonds to the metals in the cooling system to provide optimum corrosion protection. Protects aluminum and all other engine metals.

Prestone Extended Life Antifireeze/Coolant Ingredients (orangish color)--Ethylene Glycol (107-21-1), Diethylene Glycol (111-46-6), water (7732-18-5), Sodium 2-Ethyl Hexanoate (19766-89-3), Sodium Neodecanoate (31548-27-3) and proprietary corrosion inhibitors. Contains no phospates, nitrites, silicates, borates or amines. Improved water pump life. Compatible with other Dex-Cool approved coolants. Silicate and phosphate free. Color Orange. Install a minimum of 50%, a maximum of 70% Extended Life which provides extended rust and corrosion protection of five years. Is recommended and formulated for use in all 1996 and newer GM vehicles except GEO and Saturn, as well as all other cars and light duty trucks with aluminum radiators. This formula has a concentrated blend of premium long-lasting inhibitors for extended performance, protecting against temperature extremes and the ravages of rust and corrosion. Extended Life has been approved by GM to be licensed as a Dex-Cool product under GM specification.

Cooling System Metals

(a discussion from the Triumph Car list)

....There are a number of metals present in automotive cooling systems. The most common metals are cast iron, mild steel, copper, brass, aluminum, high-lead and low-lead solder alloys. Generally speaking, the corrosion of metals is prevented by the formation of a stable film at their surfaces. This film might be formed by corrosion products, as when aluminum is exposed to air, or by the adsorption of some other chemical, such as silicates, onto the surface.

....The corrosion potential (rusting/corrosion level is another way of thinking about it) for metals is the result of several competing factors. The most important two are the electrode potential, a measure of the tendency of a metal to oxidize (the atoms/ions of the metal combine chemically with oxygen to form a participate or "solid"), and the protective strength and stability of the surface films. The most corrosion prone metals in an engine are aluminum and solder.
....Cast iron and steel both have relatively low corrosion rates in automobile engines. The simple, but essential, task of reducing ferrous metal corrosion is accomplished by adding inhibitors to the coolant formulation. Additionally, the corrosion products of ferrous metals are readily dissolved in the coolant and moderately stable in solution. Ferrous metals corrosion is not a major problem in the engine of most cars.
....Copper and brass, an alloy of copper and zinc, have higher corrosion rates then iron and steel. The only major alternative to the brass and copper radiator is an aluminum and plastic radiator. Like ferrous metals, the corrosion of brass and copper can be easily controlled through the use of inhibitors.
...The corrosion of aluminum can be quite a problem. Based on its electrode potential, aluminum is the most corrosion prone metal in an engine. Only magnesium, sodium and potassium have a greater oxidation potential (these metals will burn/oxidize violently). The reason our precious engines do not turn into lumps of white powder is that aluminum oxides tend to form stable surface films on the cooling/engine waterways. However aluminum is particularly sensitive to a process, called erosion-corrosion where a rapidly flowing fluid can remove the protective oxide layer. Erosion can be controlled by limiting the surface flow rate of coolant to 3 m/s or less. This is easily achieved everywhere except at the water pump.
....Which leads to a brief aside about the most vulnerable aluminum component in many engines, the water pump. Water pumps and their housings are susceptible to corrosion caused by erosion-corrosion and cavitation.
....Cavitation causes the formation and subsequent collapsing of high pressure vapor cavities, which exert high mechanical forces on metal surfaces. Erosion-corrosion is the process whereby a flowing fluid surface destroys the protective film giving corrosion free play. The results of both processes are very similar, namely severe **localized** damage. Cavitation and erosion-corrosion are difficult to separate under test conditions.
....The rate of cavitation is affected by a number of factors. Increasing the fluid density or fluid **boiling** point tends to increase cavitation while increasing viscosity, compressibility or dissolved gases tends to reduce cavitation. Some of these properties are effected by coolant additives and the effect on cavitation is one of the characteristics of a coolant package that should be considered.
....One final problem with aluminum. Some aluminum salts, most notably aluminum phosphate, are not highly soluble in water. Depending on the overall coolant hardness, which is the measure of the total concentration of minerals in the coolant, aluminum salts will precipitate out of solution in the cooler parts of the coolant system.
....The last important metal alloy in the typical coolant system is solder. Solder, like aluminum, is highly susceptible to corrosion. There are two common solder alloys. Low-lead solder is made of about 70% Lead (Pb) and 30% Tin (Sn). High-lead solder is 97% Pb, 2.5% Sn and .5% silver (Ag). As a practical matter, even though it has a decent electrode potential, lead is probably the least corrosion resistant metal in the automobile. This is because lead does not form the stable protective oxide film that aluminum does. Since lead salts are the primary corrosion by-products of solder, it follows that cheaper, modern high-lead solder corrodes at a faster rate than the low-lead solder.
....Usually the corroded solder forms an insoluble scale at the corrosion site. In fact, a solder joint will often oxidize completely, but remain plugged by the corrosion products. Unfortunately, salts are not well known for there mechanical properties so failure can occur when the salt plug is cracked by vibration.
....The primary failure of radiators occurs through the corrosion of the solder joints between the radiator tubes and the inlet or outlet manifolds. Depending on the construction technique, this can be a horrendous and messy problem. Some radiators, called "soft-cored", have cross tubes that are completely solder lined and which can solidly pack with scale. It is the removal of this scale that we call "rodding out" a radiator. A more sophisticated mechanic can remove this scale by

dipping the radiator in a caustic solution.
...Clad aluminum has been used to control corrosion and prevent metal pitting and perforation in radiators. An alloy of 99% Al/ 1% Zinc (Zn) is coated on an aluminum surface. In this composite structure, corrosion will proceed preferentially along the alloy surface owing to the lower electrode potential of the Al/Zn composite. If the cladding is applied properly, it can be quite effective at preventing pitting and perforation. If not, the cladding can flake off the surface and create new particulate headaches. An underlying assumption of this strategy is that no radiator lives forever. It only lives a bit longer than the cladding on its surface.

Coolant Chemistry

(a discussion from the Triumph Car list)

....The major component of coolant is water which is a great heat transfer fluid.
....The next major component is the base of the concentrated coolant, as purchased at the store.
....There are two major base chemicals that commonly are used. Ethylene glycol (EG, generally green) is the most common base. Less common is propylene glycol (PG, generally orange or reddish), which has been used for years in Switzerland owing to poison laws and is a recent entry in the U.S. market.
....One function of the coolant is to lower the freezing point of the mixture in the system. Another function of the coolant is to raise the viscosity (thickness) of the coolant mixture. Higher viscosity mixtures will reduce cavitation at the water pump. PG (orange stuff) and EG (green stuff) will both raise the coolant viscosity, methanol will not.
....A variety of different chemicals are added to coolants to inhibit corrosion. Called inhibitors, the function of these additives may be to form a stable, protective film on the metal surface or to alter the solution properties of the coolant. Really, the precise mechanism of protection of some additives is not known by anyone who is willing to publish their results.
....Common corrosion inhibitors include: sodium phosphate, sodium nitrate, sodium tolytriazole, sodium molybdate, sodium borate, sodium benzoate and sodium silicate. These are all sodium salts. Actually, only the right hand group of these salts is chemically the inhibitor, i.e., benzoate or silicate. These salts dissociates in water, in other words, they separate into sodium, with a positive charge, and the inhibitor, with a negative charge. The sodium salts are used because of the high solubility (readily splits off and stays in solution) of sodium. There would never be sodium deposits in your engine.
....Different inhibitors protect different metals.
....Aluminum heat-transfer corrosion is best inhibited by silicate and most poorly by phosphate and borate.
....Copper is best inhibited by molybdate and most poorly by benzoate; high-lead solder best by molybdate and phosphate and most poorly by nitrate, silicate and benzoate; low-lead solder best by tolytriazole and molybdate and most poorly by nitrate and silicate;
....Mild steel best by molybdate, phosphate and nitrite and most poorly by tolytriazole and benzoate;
....Gray cast iron best by nitrate and most poorly by benzoate, tolyriazole, and borate; and cast aluminum best by silicate and most poorly by phosphate and molybdate.
....Phosphate is the most ubiquitous and most controversial inhibitor. It is a well known inhibitor of ferrous metal corrosion, hence trisodium phosphate is used to clean off sheet metal. American car manufacturers have specified phosphate in coolants because it is highly effective at preventing cavitation. Europeans specify non-phosphate coolants because phosphates have a propensity to precipitate in hard water. Also, phosphates have a negative effect on the corrosion rate of aluminum. This beneficial effects peak at concentrations of about 3 gm/liter and decreases at both lower and higher concentrations. Typical concentrations in coolants range from 0 to 8 g/l.

....Nitrate is included in virtually all coolant formulations because of its efficacy in preventing aluminum radiator pitting, with presumably no negative side effects for other metals. A typical concentration is 2 g/l.
....Tolytriazole is similarly included in virtually all formulations owing to its effectiveness in preventing cupreous metal corrosion. A typical concentration is 1 g/l.
....Molybdate is a broadly beneficial additive. It prevents corrosion in many metals and acts synergistically with phosphates and silicates to prevent corrosion in others. Molybdate also seems to prevent cavitation damage; it is usually selected to perform this function in non-phosphate coolants. Typical molybdate concentrations are 2 to 3 g/l.
....Borate is the most commonly used buffer for coolant systems. Off the shelf, American coolants tend to have a pH of 10 or higher (this is an alkaline pH), while European coolants tend to have a pH of 7 to 8.5 (which is near neutral to very slightly alkaline). In service, the pH of American coolants often drops to 8. Unfortunately, borate tends to have a direct and negative effect on aluminum corrosion. In spite of this, the importance of keeping coolants well buffered is great enough to keep borate in coolant formulations. A typical concentration is 4 g/l.
....Benzoate (and Nitrite, which is not mentioned here) are part of the British Standards Institute's [BSI] Corrosion Inhibited Ethanediol Anti-freeze formulation. Benzoate is more common in European coolants than American coolants and is described as a ferrous metals corrosion inhibitor.
....Finally there are silicates, which appear to be ultra necessary in the protection for aluminum. The problem is that silicates are not indefinitely stable in solution. While other additives can be used to stabilize silicates somewhat. The lifespan of coolants could be considered by the presence of an adequate silicate concentration. 2 g/l is an effective concentration of silicate.
....Bringing all of these inhibitors together, a combination of benzoate, molybdate, borate, nitrate, tolytriazole and silicate is a good additive package that doesn't use phosphates. The non-silicate part of the package is fairly effective in preventing aluminum corrosion, and makes a good back-up system in for an aluminum block engine, should the silicates become depleted.
....Other additives appear in coolants as well. These agents are typically used to stabilize the inhibitors or the metal salts which are corrosion by-products. This type of additive is called a sequestrants. Another required additive is the colorant.

Some Questions and Answers

(a discussion from the Triumph Car list)

How long does coolant last?
....You can definitely trust your coolant, phosphate containing or not, for about one year of average use. Coolant has a definite lifespan even in storage. It would be wise to replace the coolant in an aluminum engine at least every 2 years.

How can coolant go bad?
....The primary failure of coolant is depletion of some inhibitor. For an aluminum block engine this is the silicate. Another failure is saturation with some metal salt, such as aluminum phosphate, which then precipitates at some inconvenient location in the engine.

Should I use tap water or distilled water?
....Distilled water is recommended. Exceptionally soft water would be acceptable. Basically, the engine metals are going to corrode to some extent no matter what water you use, and hard water will encourage the resulting metal salts to precipitate.

How often should I change coolant?
....Flush and refill annually with 50% coolant - water mixture. If you do this you may never experience any cooling system corrosion problems.

What coolant should I use?
....If you are willing to religiously flush and change your coolant annually, any aluminum compatible coolant will do. "Aluminum compatible" are usually the code words for "contains silicates". As long as a decent silicate concentration is maintained, the presence of phosphate is unimportant. Aluminum corrosion was extemely low in the presence of phosphate, as long as the silicates were not depleted. Aluminum corrosion rapidly accelerates once the silicate concentration drops. If you are not up to annual changes, a phosphate-free, aluminum compatible coolant may be the best choice.

Can I use propylene glycol?
....I think that this is a matter of personal preference. PG (orange) is still more expensive than EG (green), but it is definitely less toxic or environmentally damaging. The performance of inhibited PG coolants is comparable, indeed better, than EG in most cases. The only negative effect I know of is that inhibited PG is less effective at preventing cavitation pitting in steel than inhibited EG.

Why is coolant green?
....Because the **SAE** Handbook says it's supposed to be dyed green or blue-green. By using standard colors one could tell what fluid are leaking by simply examining the stains on the ground.

Why use a Coolant?

----The main purpose of mixing glycol with water is to lower the freezing point and to raise the **boiling** point of the coolant mixture. Glycol also improves
the anti-corrosion properties of the water. But glycol affects the heat transfer characteristics adversely, to a small extent. Pure ethylene glycol has a thermal conductivity coefficient only 40% that of water. Its thermal diffusivity, a measure of a substance's ability to absorb heat, is about 50% that of water. So, used alone, it is not a very good heat transfer fluid. It is also quite viscous (hard to pump). When glycol is mixed with water, say in the usual ratio of 50:50, the heat transfer capacity of the mixture is reduced, but only about 15% compared to pure water. Everything else being the same, you would have to circulate 15% more coolant volume to get the same cooling effect as water. Conversely, replacing your antifreeze solution with water would improve cooling by 15% or so. A system properly designed for glycol mix should obtain sufficient cooling. But if the heat exchanger (radiator) has been damaged, or has become fouled, then switching to water or a lighter glycol mix could restore some performance. There are not any choices for coolant for service at normal engine temperatures (~200F) that are as benign, cheap and effective as water/glycol mix. Various oils can be used at much higher temperatures Oil plays at least a part in cooling all engines. Some motorcycle engines have oil cooling passages in the head or cylinder walls. Light oil has about the same heat transfer characteristics as pure glycol.

Clips from Popular Mechanics material----

but go to the site and read the entire article for more details

http://popularmechanics.com/automotive/sub_care_sat/1999/3/right_coolant/

…. **All antifreeze is not compatible**. There are cases where you can get a fast case of corrosion. Cases where the water pump can be both eroded and corroded to failure. Plus many cases where you can shorten the effective life of the antifreeze by mixing types.

.... Antifreeze itself (the green stuff) is most commonly a chemical called ethylene glycol, does not wear out, never. But the key ingredients, the rust and corrosion inhibitors, do get used up. The most common inhibitors, the silicates used for aluminum protection, are used up faster than others. That is why some new cars (all General Motors, Mercury Cougar, VW/Audi models) have red or orange antifreeze with a new class of inhibitors, called organic acids. Examples of U.S. brands with these organic acids: Havoline Dex-Cool and Prestone Extended Life, both recommended for five years or 150,000 miles. That's the good news.

....Can the orange antifreeze be used in every cooling system? No, that is the bad news, **the new organic acid antifreezes may be used only if the cooling system has an aluminum radiator, rather than copper-and-brass.**

….If you intend to drain out all the old antifreeze from any system, thoroughly rinse the system with fresh water. The idea in any case is to rinse your cooling system well, until the liquid is clear water. However it probably takes about three complete drain/refill cycles--draining the system and filling with water, then letting the engine warm up and cool down between each cycle--to get 85 to 90 percent of the old coolant out. So this is usually not going to happen. Normally draining and flushing is about all that the average person/shop will do.

....Close the system up then fill the system with water, top up the reservoir and run the engine until it's warmed up. Let the engine cool, drain the radiator and if the coolant is clean and clear. Completely drain the system again, then fill with coolant/water mixture. Fill slowly to allow trapped air to escape. Complete filling of a system can take lots of " thermo-cycling"–warming up the engine and letting it cool down–to purge all the air pockets, and, in fact, you may have to recheck the system over a period of a week or more of operation.

....Why a higher percentage of coolant is not better----Water, with the proper anticorrosion additives, would make an adequate cooling medium for engines, but it freezes, and boils over. Ethylene glycol, an alcohol, is added to extend the **boiling** and freezing points of the coolant. Why not run pure glycol, and get better freezing/boil-over protection? Pure ethylene glycol will freeze at essentially the same temperature as water. At concentrations higher then 70 percent or so, freeze protection is not very good. Also, ethylene glycol doesn't carry as much heat from the engine to the radiator as an equivalent amount of water, which can result in overheating. Stick with concentrations of 50 percent to 60 percent water/ antifreeze.

….The maximum coolant amount possible is 68 percent, which would be freeze protection to a minus 92°F. A higher concentration than 68 percent causes the freeze point to start rising. A 50-50 mixture will give minus 34°F protection. Higher concentrations of coolant may not provide correct anticorrosion protection, so there's really no point in using more.

Corrosion in cooling systems, two types----

....Oxidation of enough metal in an area of the cooling system can lead to leaks and coolant flow issues. This occurs most often in radiators and water pumps. Tiny holes in radiators are often plugged with the corrosion by-products themselves thus the radiator may be more corroded than appears. In water pumps corrosion will reduce coolant movement, cause leaks around the housing, and if extreme, mechanical damage can occur.

....Another type of corrosion is extensive scale formation which blocks the coolant pathway, reducing flow and heat transfer from the liquid coolant to the metal of the radiator, and finally from the metal to the air. Scale starts with metal

ions either in hard water or from the metals in the passageways of the cooling system and engine reacting with the acids in the coolant/water solution. The metal replaces the hydrogen ions of of the acids forming a metal salt, which is often a metal ion combined with the acid radical such as a carbonate, sulfate, etc. Thus the metal salt is in solution in the hottest parts of the cooling system but when the temperature of the solution cools down, such as in the radiator area, some of these metal salts precipitate or come out of solution at a scale or semi-solid, thus restricting flow and even clogging the smaller passages of the cooling system, such as the radiator.

....Another important consideration in understanding corrosion in internal combustion engines is heat flow. Metal that is heat-rejecting (gives up heat) has a higher corrosion rate than metal that is heat-absorbing or heat-neutral. Heat-rejection is the transfer of heat from metal to coolant, i.e., in the engine block is heat-rejecting. One reason for this accelerated corrosion is coolant **boiling** at the surface of such surfaces. To quote a favorite phrase of engineers, physicists and biologists, combined **boiling**, heat transfer and corrosion are "not completely understood", but bench tests clearly show increased corrosion at heat-rejecting metal surfaces.

WHAT KIND OF WATER IN THE COOLING SYSTEM?? Distilled, De-ionized, Tap, Soft??

------Cooling systems require the minerals in the water. Using distilled water causes the action of the coolant to attack the radiator and engine block to get those minerals.

------"This is the first time I've heard this one. Every other "expert" I know of advises the use of distilled water. This includes the Honda service manual for the VF1100S and the Honda Common Service manual. I've been using distilled water in my xxxxxx and 80k miles.

-----My opinion is, distilled water would be a better solvent of radiator metal than water buffered with some minerals, especially those with lots of iron and copper minerals. Thus, in some areas it is absolutely correct. Also, distilled water dissolves CO2 and that forms a little carbonic acid (H2CO3) which has an appetite for metal and makes carbonates e.g. Fe2(CO3)3 or CuCO3. Probably of little consequence in a radiator because 1) closed and 2) heat would degas it.

....But, 1) If you're running ordinary (silicate containing) anti-freeze then you don't want additional solutes (minerals/metal ions) in the coolant that may cause the silicates to precipitate (a Bad Thing) you want to keep them dissolved (a Good Thing). Thus, distilled water is the Best Thing. 2) If you're running non-silicate anti-freeze then silicate precipitation is a non issue.

-----If you live in an area with high mineral content in your tap water, mix it with de-ionized water instead to prevent deposits in the cooling system. RESPONSE: Do not use anything but purified drinking water to mix with your anti-freeze. Cooling systems require the minerals in the water. Using distilled water causes the action of the coolant to attack the radiator and engine block to get those minerals. Long story how I came across this, but tiny little pin holes will develop in the radiator over time is distilled water is used.

------One thing you should keep in mind, is that you should be careful of the contents of the coolant. My local dealer has something posted with regards to some coolants containing silicates. These *things* are very similar to granules of sand. Their sole purpose in an automobile's engine is to be a sort of roving SOS pad. That is, the action of them moving about

in the cooling system scrubs any build up off the walls of the passages. In a car with lots of metal, no prob. But in a motorcycle engine, they have been know to EAT the seals around the water pump and even damage other components. Just read the label.

------The only thing I can think of is this: where there is water, there is corrosion. Having some sacrificial material, such as a zinc anode, will keep the water from attacking the engine and radiator. Boaters with exposed aluminum hulls know this.

------Thinking that distilled water, without coolant, by itself would be the trick for a clean system. The experience we had was too clean. It chewed up head gaskets and attacked the metal in the radiator and tore up pumps.

------DeIonized water is pretty much just H2O. DeIonized water will try to return it it's natural state prior to purification. Over time it will leach minerals from **whatever** it comes in contact.

....Did someone ask for a litmus test? DI water left standing long enough will actually go from a pH of 7 (neutral) to 4 (acidic). Don't scoff...I've already done it for you. I performed the experiment myself when a Safety Engineer said it can happen. It's true. Now the real question...is DI & distilled water the same? Then antifreeze kind of throws a wrench in the mineral debate.

------With a possible exception the "water dissolves anything," assessment would be correct. You see this effect in groundwater quite regularly. The minerals in your Perrier were once rock that the water simply dissolved over time as the water tried to reach an equilibrium with its surroundings. A radiator is no different than an underground cave to the water. The fact that your distilled water has no minerals in it simply means it has more "dissolving potential" since it is further out of equilibrium with its environment than more mineralized water would be. The exception: most coolants include corrosion inhibitors that should, in theory, prevent this kind of action, but it is possible they don't work well in protecting the metal from corrosion caused by highly energetic distilled water.

----------I'm hardly a chemist, but I'd love to hear the scientific explanation as to why a water/coolant mix attacks the metals of an engine and radiator. Yes, the explanation has to be better than anecdotal evidence.
….RESPONSE: I'm no chemist, but I did have a brief stint learning chemistry before deciding computers were more worth my time. The amount of corrosion you get depends on a whole lot of things, including: the temperature (and how steady it is), the amount of dissolved oxygen, the Ph (acid/base level), if you have multiple dissimilar metals connected to each other, the conductivity of the water itself, the amount of stress the metal is under, etc. For instance, iron is more or less famous for rusting in water. However, it turns out if you take very very pure iron (no carbon at all), and distilled water, the iron will in fact rust very very slowly if at all. Add carbon to the iron and salt and air to the water, and the situation changes.
....Pure water is not very corrosive, but if it's exposed to air, it will dissolve oxygen and CO2. The CO2 turns into carbonic acid, H2CO3, which means the pH drops, and the water becomes more conductive. The oxygen that's dissolved can then attack the iron & the situation goes from there. Aluminum is actually a very reactive metal, much more so than iron. It really likes to combine with something. If you mix aluminum powder, and iron oxide, and light it off with something hot enough (such as burning magnesium), the aluminum will cheerfully steal the oxygen away from the iron, and release a *lot* of heat (plus generate white hot molten iron) in the process. This is the thermite reaction, which is sometimes used for welding.
....The reason why aluminum can be used in engineering is that normally, as soon as it's exposed to air, it starts to

combine with the oxygen. The product is aluminum oxide. Now, when iron combines with oxygen, the resulting iron oxide takes up more space than the iron. Therefore, rust flakes off. Aluminum oxide, on the other hand, takes up almost exactly the same amount of space as the aluminum from which it formed. Aluminum oxide is also very hard, almost completely insoluble in water, and is an electrical non-conductor. It's almost the perfect protective coating for aluminum, so it's only when people do stupid things like try to use aluminum for house wiring that bad things happen. The coating that aluminum forms when just exposed to air is not very thick, so sometimes "anodized" aluminum is used, which is just aluminum treated so that it grows an extra thick layer of aluminum oxide. While aluminum *oxide* is almost insoluble, other salts of aluminum aren't quite so convenient. If I remember right, aluminum chloride is slightly soluable, and the result is that it's possible to get pitting. Acids in general are also bad, including to some extent carbonic acid (as in dissolved water.) Hence, aluminum cookware which is exposed to lots of sodium chloride (in most foods) and acids (anything sour) tends to pit with time. So coca-cola would probably be a really terrible coolant for cycles.. Sea water might be only slightly better.
....Most chemical reactions happen much faster with increases in temperature. The thermite reaction just doesn't happen at room
temperature, for instance. Even between ice water & room temperature there is a distinct difference - this is one of the reasons why we keep food in refrigerators.

....For corrosion, there is another factor that counter-balances this - warm water can dissolve and hold less dissolved oxygen and CO2. This is why tap water fresh out of the hot water heater is cloudy - that's all the air the water couldn't hold anymore when it was heated up. Salt water also holds less oxygen & CO2 - adding salt to water will also cause some of the air to boil out. In the ocean, it's possible to find deep currents of very cold sea water with little dissolved oxygen/CO2 in it, because it got sucked under while warm and didn't have a chance to absorb any more oxygen while and after it cooled. Iron, which might rust *very* quickly at the surface (exposed to alternating air & warm salt water) will often rust much more slowly at the ocean floor, if it's exposed to this kind of sea water. That's why the titanic is still findable after 90 years at the bottom.

....Whenever you've got 2 different metals, you have the essential elements of a battery. A very simple battery can be made by taking a strip of zinc, a strip of copper, and sticking them into a lemon (or any vegetable, they're all acidic), or into vinegar or, gosh, battery acid. In this type of battery, one metal corrodes while the other one doesn't. The corrosion process happens much faster if the two metals touch.

....Metal that is under stress typically corrodes before metal that isn't stressed. In a muffler system, this is why the metal attaching it rusts out before the rest of it. Or at least that's the theory, I know an electrical engineer who claims that this isn't true at all, and metal under stress doesn't corrode any faster.

....So, now, on a cycle, we have at least 3 different metals - the copper of the radiator, the aluminum of the engine itself, and I'm guessing there's some iron in the water pump or *somewhere*. Assuming all are well grounded, the aluminum of the engine will corrode to protect the radiator and any iron. If the coolant is added to the engine and then just used, when the engine heats up, it will boil most of the air out of the water, and when it sits, some of the air may slowly dissolve back in (as it sits in the radiator, overflow bottle, and any trapped
bubbles.) Hard tap water may dissolve slightly less air (so less O2 and CO2). However, hard tap water may instead form silt or sludge,
which could gunk up the radiator, or cause erosion problems. Brackish tap water (dissolved salt) could be worse (chlorides.) If you have a water softener in the house, the softened water may have more chlorides in it, so could be

worse than the hard water.

....Anti-freeze probably contains its own dissolved mineral content - so it should automatically provide the same protective effect as tap water. The minerals selected are formulated so that they aren't likely to turn into silt and do those bad things - unless mixed with tap water in which case it depends on how hard the tap water is, and what exactly is making it hard. I believe they put additional gunk (chelates?) in which are also protective against corrosion until they wear out (a year or so, depending on ?) Very old anti-freeze may also turn acidic which is bad. (Anti-freeze and brake fluid apparently contain some of the same chemicals?!)

....I'm guessing he likely changed his coolants between every race, and may have been more concerned with the very expensive engine life than with the relatively cheap copper radiator (or may even have been using a plastic radiator?) So I can see where pure distilled water could be bad there. I doubt this will have anything to do with how it will perform if mixed with anti-freeze in the recommended ratio. Soft tap water may not perform much worse than distilled water, especially if not changed too often, or flushed everytime it's changed. Hard tap water and no flushing might produce sludge.

....In theory, it would be worth replacing any iron components in the cooling of the system (I don't know why, but I've never heard of an aluminum radiator.) On the other hand, if I wasn't imagining things, I think Honda uses part of the iron frame for the coolant return in the early V4's, so this is probably not very feasible.

----------My bad experiences came when we could only run water without anti-freeze on the track. Thinking that distilled water (without coolant) by itself would be the trick for a clean system. The experience we had was too clean. It chewed up head gaskets and attacked the metal in the radiator and tore up pumps. I then tried some bottled drinking water (without coolant) and ran a whole season without a single problem. I eventually came up with an oil cooled system which worked for 15+ years. Granted, mixing the distilled water with anti-freeze changes the chemical make-up, but I figure that if distilled water used by itself causes
problems and purified drinking water does not it should be better to mix with. Only my opinion, but for the two recent engine rebuilds I just did with leaking head gaskets, I'll stick with the mix I know works for me.

----------Running straight water, regardless of whether it's tap or distilled, usually isn't too good of an idea. Water and the air that will inevitably be mixed in with it will always be corrosive in a cooling system. Also, water pump seals need some sort of lubrication or they'll fail. Never heard of head gasket problems related to pure water, but who knows. Maybe their composition doesn't get along with pure water for some reason. Antifreeze has rust inhibitors in it and acts as a lubricant for the pump seals. These are the exact reasons that companies like Redline came up with products like Water Wetter. Tracks don't allow antifreeze and something needed tofill the gap for corrosion resistance and seal lubrication when running straight water.

---------- IMHO, distilled water + non-silicate antifreeze is just fine. I've been running that combo for many years in both cars and motorcycles with no problems.

--------Thinking that distilled water (without coolant) by itself would be the trick for a clean system. The experience we had, it was too clean. It chewed up
head gaskets and attacked the metal in the radiator and tore up pumps.
.....Response: De-Ionized water is pretty much just H2O...not much else.. DI water will try to return it it's natural state

prior to purification. Over time it will leach minerals from whatever it comes in contact. We have seen DI in running through PVC pipe with the pipe becoming so brittle that it would break with very little external help. Did someone ask for a litmus test? DI water left standing long enough will actually go from a pH of 7 (neutral) to 4 (acidic)....I've already done it for you. I performed the experiment myself when an engineer said it can happen....it's true. Now the real question...is DI & distilled water the same? then...antifreeze kind of throws a wrench in the mineral debate.

-------The minerals in your Perrier were once rock that the water simply dissolved over time as the water tried to reach an equilibrium with its surroundings. A radiator is no different than an underground cave to the water. The fact that distilled water has no minerals in it simply means it has more "dissolving potential" since it is further out of (electrical charge) equilibrium with its environment than more mineralized water would be. The exception: most coolants include corrosion prohibitors that should, in theory, prevent this kind of action. However, they may not work well in protecting the metal from corrosion caused by highly energetic distilled water.

--------The amount of corrosion you get depends on a whole lot of things, including: the temperature (and how steady it is) the amount of dissolved oxygen the PH if you have multiple dissimilar metals connected to each other. the conductivity of the water itself the amount of stress the metal is under etc.

------For instance, iron is more or less famous for rusting in water. However, it turns out if you take very very pure iron (no carbon at all), and distilled water, the iron will in fact rust very very slowly if at all. Add carbon to the iron and salt and air to the water, and the situation changes. Pure water is not very corrosive, but if it's exposed to air, it will dissolve oxygen and CO2. The CO2 turns into carbonic acid, H2CO3, which means the pH drops, and the water becomes more conductive. The oxygen that's dissolved can then attack the iron & the situation goes from there.
....Aluminum is actually a very reactive metal, much more so than iron. It really likes to combine with something. If you mix aluminum powder, and iron oxide, and light it off with something hot enough (such as burning magnesium), the aluminum will cheerfully steal the oxygen away from the iron, and release a *lot* of heat (plus generate white hot molten iron) in the process. This is the thermite reaction, which is sometimes used for welding.
....The reason why aluminum can be used in engineering is that normally, as soon as it's exposed to air, it starts to combine with the oxygen. The product is aluminum oxide. Now, when iron combines with oxygen, the resulting iron oxide takes up more space than the iron. Therefore, rust flakes off. Aluminum oxide, on the other hand, takes up almost exactly the same amount of space as the aluminum from which it formed. Aluminum oxide is also very hard, almost completely insoluable in water, and is an electrical non-conductor. It's almost the perfect protective coating for aluminum, so it's only when people do stupid things like try to use aluminum for house wiring that bad things happen. The coating that aluminum forms when just exposed to air is not very thick, so sometimes "anodized" aluminum is used, which is just aluminum treated so that it grows an extra thick layer of aluminum oxide.
....While aluminum *oxide* is almost insoluable, other salts of aluminum aren't quite so convenient. If I remember right, aluminum chloride is slightly soluable, and the result is that it's possible to get pitting. Acids in general are also bad, including to some extent
carbonic acid (as in dissolved water.) Hence, aluminum cookware which is exposed to lots of sodium chloride (in most foods) and acids (anything sour) tends to pit with time. So coca-cola would probably be a really terrible coolant for cycles. Sea water might be only slightly better.
....Most chemical reactions happen much faster with increases in temperature. The thermite reaction just doesn't happen at room temperature, for instance. Even between ice water & room temperature there is a distinct difference - this is one of the reasons why we keep food in refrigerators.
....For corrosion, there is another factor that counter-balances this -warm water can dissolve and hold less dissolved

oxygen and CO2. This
is why tap water fresh out of the hot water heater is cloudy - that's all the air the water couldn't hold anymore when it was heated up salt water also holds less oxygen & CO2 - adding salt to water will also cause some of the air to boil out. In the ocean, it's possible to find deep currents of very cold sea water with little dissolved oxygen/CO2 in it, because it got sucked under while warm and didn't have a chance to absorb any more oxygen while and after it cooled. Iron, which might rust *very* quickly at the surface (exposed to alternating air & warm salt water) will often rust much more slowly at the ocean floor, if it's exposed to this kind of sea water. That's why the titanic is still findable after 90 years at the bottom.
....Whenever you've got 2 different metals, you have the essential elements of a battery. A very simple battery can be made by taking a strip of zinc, a strip of copper, and sticking them into a lemon (or any vegetable, they're all acidic), or into vinegar or, gosh, battery acid. In this type of battery, one metal corrodes while the other one doesn't. The corrosion process happens much faster if the two metals touch. Metal that is under stress typically corrodes before metal that isn't stressed. In a muffler system, this is why the metal attaching bit rusts out before the rest of it. Or at least that's the theory, I know an electrical engineer who claims that this isn't true at all, and metal under stress doesn't corrode any faster.
.....So, now, on an early Honda V4, we have at least 3 different metals - the copper of the radiator, the aluminum of the engine itself, and I'm guessing there's some iron in the water pump or *somewhere*. Assuming all are well grounded, the aluminum of the engine will corrode to protect the radiator and any iron. If the coolant is added to the engine and then just used, when the engine heats up, it will boil most of the air out of the water, and when it sits, some of the air may slowly dissolve back in (as it sits in the radiator, overflow bottle, and any trapped bubbles.) Hard tap water may dissolve slightly less air (so less O2 and CO2). However, hard tap water may instead form silt or sludge, which could gunk up the radiator, or cause erosion problems. Brackish tap water (dissolved salt) could be worse (chlorides.) If you have a water softener in the house, the softened water may have more chlorides in it, so could be worse than the hard water.
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.....In theory, it would be worth replacing any iron components in the cooling system with aluminum, and insulating the copper radiator from the rest of the system (I don't know why, but I've never heard of an aluminum radiator.) On the other hand, if I wasn't imagining things, I think Honda uses part of the iron frame for the coolant return, so this is probably not very feasible.

-------Different posts recently have discussed radiator coolant. Referring in some to the "BAD" green stuff and the "GOOD" orange stuff. Referencing the bad silicates in the green that aren't there in the orange. There has also been dissenting and opposing views on this same "color" reference as to which is good or bad I run the green stuff now, diluted approx. 50:50. Outside of the bottle says ok for aluminum engines. Is this all that's required and enough said on the subject? Recommendations, thoughts, opinions (not that I expect anyone here to be opinionated) :o) would greatly be appreciated.

.....Aluminum block, brass radiator, steel cross over tubes, aluminum?? (maybe die-cast zinc alloy) thermostat housing, thermostat is steel and brass. I think that covers most of it. And an aluminum water-pump housing, and I am pretty sure the hoses are synthetic rubber.

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WHAT ABOUT THE SILICATES FOUND IN THE GREEN STUFF??

....Silicates can be abrasive (such as beach sand) or lubricious (such as hydrous magnesium silicate - talc). Soluable silicates are made, e.g., by reducing silicon dioxide, SiO_2 (sand) into SiO_4^{-4}. (Throw in the caution of your choice.) So, presumably, the reverse can happen, meaning SiO_4^{-4} will be oxidized in SiO_2. So, the water soluble silica ions in your green coolant can oxidize into rather non-soluable, and abrasive, sand. (Though, making sand by oxidizing silane (SiH_4) is a hell of a lot more fun.)

....Silicates are abrasive particles that help keep deposits from forming on critical parts of the cooling system. AFAIK, silicates are actually corrosion inhibitors. They only become abrasive over time as they oxidize. Silicates can be abrasive (such as beach sand) or lubricious (such as hydrous magnesium silicate - talc).

....I didn't believe that green anti-freeze comes out of the bottle with abrasives in it. Seems I was wrong. Havoline fesses up at: http://www.havolineusa.com/Products/body_antifreeze.html Click on the "full specs" link at the bottom of the page.

....Silicates are abrasive particles that help keep deposits from forming on critical parts of the cooling system. AFAIK, silicates are actually corrosion inhibitors. They only become abrasive over time as they oxidize. Motorcycles have much smaller components than cars/trucks with tighter tolerances. There has been som rather speculative information indicating that silicate-containing antifreeze may erode the seals in the water pump faster than silicate-free coolant.

....The only confirmed reports (that I've read of) of motorcycle water-pumps reacting badly to old fashioned green antifreeze have been with Honda Goldwings.

....FWIW, Honda's blue-green pre-mixed coolant is silicate-free (and expen$ive). The orange long-life stuff is silicate free so that's what I use. Cheap insurance IMHO.

....The folks over at Popular Mechanics are against retro-filling systems with "the orange stuff". See: http://popularmechanics.com/automotive/sub_care_sat/1999/3/right_coolant/
So, do early Honda V4's have aluminum radiators?

--------Sand is a grain size class - anything with a particle diameter between 1/16 mm and 2 mm is sand. SiO_2 is the mineral quartz. Many people equate sand to quartz, but sand sized particles need not be composed of quartz. For example,most of the sand beaches of Florida and the Caribbean islands are composed of calcite $CaCO_3$ sand. So, the water soluble silica ions in your green coolant can oxidize into rather non-soluable, and abrasive, sand. The SiO_2 that precipitates from this reaction would more likely be silt-sized (1/16 mm-1/256 mm) SiO_2 - still abrasive, but smaller than sand. Further, at low temperatures (<<than magma chamber temps) probably noncrystalline hydrated SiO_2.

....I use a 50/50 mix of standard Texaco antifreeze/coolant (green). This product does not contain silicates like Prestone does. The juries out on orange stuff, which is for use in today's newer plastic coolant components. I mix the coolant with purified drinking water, rather than distilled water (that discussion has been beat to death). I have had the opportunity to remove heads that have run my mix for two years, and the systems are clean with a whitish coloring on all surfaces. Engines I have had apart that were switch to orange stuff didn't look as good, but this could be that the crud was already there.

-----One thing you should keep in mind tho, is that you should be careful of the contents of the coolant. My local dealer has something posted with regards to some coolants containing silicates. These *things* are very similar to granules of sand. Their sole purpose in an automobile's engine is to be a sort of roving SOS pad. That is, the action of them moving about in the cooling system scrubs any build up off the walls of the passages. In a car with lots of metal, no prob. But in a motorcycle engine, they have been know to EAT the seals around the water pump and even damage other components.

------ IMHO, distilled water + non-silicate antifreeze is just fine. I've been running that combo for many years in both cars and motorcycles with no problems (unless you call a failed water pump in a 15 year old 100K+ Chevy a problem).

DexCool (a must read)

Equilon (owned by Texaco® and Shell®) markets a European coolant technology (OAT) that consists of ethylene glycol inhibited with acombination of sebacic acid and 2-ethylhexanoic acid supplemented with tolyltriazole. It was originally called "Long Life", but a lawsuitbrought by Warren Oil, who markets a fully formulated coolant under the brand name "LongLife®) forced the retraction of that term form the DEXCOOL, Texaco and Caterpillar® packaging. The combination of a mono and dibasic carboxylic acids permitted Texaco to obtain a patent on the specific combination. Other companies have obtained similar patents, by varying the mixture somewhat and by using similar, but not exactly the same, chemistry.

General Motors® has been using this coolant technology in their cars and light trucks since the start-of-production of the 1996 model year vehicles (except Saturn®, which began in 1997). GMC® medium trucks equipped with Caterpillar engines, have been getting a nitrite-added form of DEXCOOL (NOAT) to insure protection against wet sleeve liner cavitation-erosion.

Can DEXCOOL organic acid antifreeze be mixed with ethylene glycol antifreeze?
DexCool is an ethylene glycol based antifreeze! The concern with mixing comes from the fact that there are very different chemical inhibitor packages in use. Most leading technologies will work very well when used as intended, typically at 50% in good quality water. If the coolants become mixed with DexCoolL, however, one study showed a possible aluminum corrosion problem in certain situations. The other question is a concern for dilution of the protection packages. At what mix is the there too little of either inhibitor to protect the engine? As a precaution, both GM and Caterpillar instruct that contaminated systems must be maintained as if they contained only conventional coolant.

How long will it last?
Uncontaminated, the engine manufacturers instruct that it may be kept in service for 5 years or 150,000 miles in cars. In trucks, Caterpillar and GM currently recommend that the nitrited version of the coolant be run 300,000 miles or 2 years, re-inhibited with a nitrite-tolyltriazole "extender", and run to a total of 600,000 miles.

Are there different brands that meet the spec?
Yes. Any brand displaying the DEXCOOL trademark meet the spec, others advertising compatibility are from the same family of coolants.

How can a customer tell if he has DEXCOOL?
If the customer owns a GM car and has **orange** coolant, then its DEXCOOL! In GM trucks the coolant is **"orange- red",** indicating that it contains nitrite. Orange coolant in Daimler-Chrysler® vehicles is NOT Dexcool. (Daimler Chrysler owners with orange color factory coolant should consult their owners' handbooks).

Does it protect aluminum?
Yes, even though it contains no silicate, the primary aluminum protector in conventional antifreezes, published data shows that it protects aluminum.

What are the advantages of DEXCOOL compared to the previous GM 6043 factory-fill?
Compared to old-fashioned phosphated antifreeze, it may be more stable and improve water pump life. Evaluations of the two technologies to compare their respective service lives has found them comparable. In fact, a Ford Motor Company study concluded that organic acid coolants do not offer any significant advantages for the consumer over current North American coolants. In a modern car with a well maintained cooling system, current North American and OEM factory fill coolant corrosion protection can be extended far beyond previous expectations."1

What are the disadvantages?
Higher cost, possible incompatibility, limited availability.

Is it environmentally safe?
It is ethylene glycol based. It is toxic. While it does reduce coolant waste, it is not environmentally safer than conventional ethylene glyco coolant.

How can you test it?
Use a refractometer to test the freeze point. The inhibitor levels can not be cost effectively tested. If in doubt, throw it out and start over.

WHAT KIND OF COOLANT?? **Green, Orange, Dex Cool?**

and what about Water Wetter?

----------This is just warning to anyone using (or considering using) Dex Cool coolant. I work as a tech for a XX dealership. XX has admitted to problems with coolant related "clumping" in some vehicles using Dex Cool. This causes chunks of sludge to form in the radiator (and I would assume throughout the system) which drastically reduces

coolant flow. XX claims this is caused by air getting into the system, causing a chemical reaction. There is a further problem with Dex Cool: Since the changeover to Dex Cool in 1995 (or so) we have been steadily replacing block heaters (made of brass) due to corrosion related leaks. This is complicated by the fact that unlike green Ethyene Glycol, Dex Cool very rarely leaves a leak trail that can be traced to the source. This makes diagnosis more difficult and may even result in overheating due to a low cooling system level and perhaps even clumping.

For automotive applications, XX recommends changing the green coolant once every two years, but I would suggest that with the small coolant capacity of the V-Max, we can't afford to lose 5% (or more) of the cooling capability due to scale buildup or sludge. At the dealership, we use a coolant flush machine that could easily (and will) be adapted to service my Max's cooling system in an environmentally friendly way.

An interesting test is to insert both probes of a sensitive voltmeter into the coolant in the top of the filler neck (don't let them touch). There will not be a large amount of voltage produced, but any voltage indicates the coolant is acidic (normal PH level for coolant is about 7.5 or so, definitely slightly alkali). You now have a battery in your radiator, and that's not good (two dis-similar metals in the presence of an electrolyte (acidic solution) is by definition a battery).

I would suggest that despite the addition of water wetter or any other products, the best coolant to use is the green stuff, serviced at the end of each riding season (don't leave acidic coolant in your rad over the winter) and at the correct mixture ratio (to keep the seals lubed

----------This is a copy of a letter I sent to a couple of tech list members when we were last talking about Dex Cool versus green coolant. My personal opinion about Dex Cool is not positive (to say the least). I think it would be a huge mistake to install Dex Cool into anything that didn't have it from the factory (and even then I would consider changing to ethylene glycol).

LETTER---Let me first say that I am not an expert on motorcycle cooling systems; I'm just a mechanic who loves his Vmax and would hate to see any other Maxes hurt or burnt up. I don't have any info on the other types of silicate free coolants at this time. I do know that despite all the rantings of the producers of Dex Cool (yes it is a silicate free coolant), we have seen more problems with heater cores, block heaters, and water pumps since the switch than before. My personal beef with Dex-cool is the difficulty in diagnosing some coolant leaks. IF the leak appears when the system is pressurized, the solution is relatively straightforward. The problem comes in when the coolant level is dropping, but you can't determine where (or even when) it is leaking from. Ethylene Glycol seems to always leave a snail trail that can be traced to the source, but Dex Cool is either wet everywhere but not leaking at this time, or not leaking at all and leaving no trace. It can make your life hell!

----------On another note, I wonder if the problem with the mechanical seal leaking could be solved by servicing the cooling system more often. I know that the coolant manufacturers list water pump (on more correctly: coolant pump) seal lubrication as an attribute, but like engine oil; these lubricants must eventually be depleted. In addition to this, the acidic nature of old coolant may be attacking the seal. This is not including the damage being done to all of the water jackets, the pump shaft and vanes, as well as the radiator. I have done bulk coolant recycling and in a 45gal drum of coolant, you end up with 2 or 3 litres of toxic "cake-like" soup that contains among other things what they call "soluble metals". These soluble metals (from what I was told) contain pieces of brass, cast iron and aluminum. I'm sure you can guess from where. This all leads back to the same thing: if the coolant is serviced regularly- even if it's a dump and fill (with distilled water in a 50/50 mix), the additive package in the coolant can never be depleted, the coolant can't become

acidic, and most of the rad plugging scale is avoided. Since the cooling capacity is listed at 3.05l in the V-Max shop manual, it isn't a costly service to perform, either. Something to consider: We spend huge amounts on synthetic oil, but yet I have yet to see a storage service list that includes draining and filling the cooling system with new coolant before storage.

----------Two further things to check are thermostat and pressure cap. The thermostat is the device that allows the engine to heat up enough to exceed 212F (100C) *at sea level*. Once the pressure exceeds the **boiling** point, the cooling system does one of two things: boils over, or begins to pressurize. If the pressure cap is faulty (either in the pressure or suction valves in the cap) the system will boil over. Keep in mind that every 3-PSI increase in internal pressure raises the **boiling** point by 15 degrees F. As coolant heats up, it expands. This also assists the pressurizing process. Once the pressure exceeds the blow off pressure of the cap, the coolant is transferred to the overflow tank. As coolant cools it contracts. Pressure in the cooling system will decrease as the engine cools. This is the importance of the suction valve: It allows the cooling system pressure to stay, at a minimum, At atmospheric pressure. If the overflow tank level is low enough to cause air to be drawn into the cooling system (or even if there is a small air leak in a hose, etc or if the weak suction spot in the system is the coolant pump seal {which can also allow dirt into the system, which will grind the seal and shaft until they leak and then the evidence is washed away}), the air in the system will cause potential aeration/cavitation of the coolant which is very hard on components (if I understand correctly, the air pocket will overheat a microscopic area of casting which then expands and breaks off of the main casting. This is repeated millions of times). Air is also vastly more compressible than coolant, which means that the normal expansion/contraction cycle is disrupted (which can result in overheating). Now back to Dex Cool. GM claims that the clumping problem is caused by air in the system, which reacts with some component in Dex Cool. The point is: the overflow tank is open to the air. The overflow tank is eventually coated with a thick layer of brown sludge (sounds familiar). In some cases the sludge is thin enough to be drawn into the cooling system during the cool down phase. This may be the beginning of the whole process.

----------I hate to arrive late to this conversation, but feel I must get my 2 cents in. IMHO using GM's Dex cool would be a huge mistake. Now without getting into the rant that I submitted the last time we discussed this, I will attempt to relay some of the horrors that Dex Cool creates. Picture a radiator in a 1998-2000 GMC Jimmy or Chevrolet Blazer that is 1/2 full of dark brown sludge. This is what happens when hot Dex Cool comes in contact with oxygen. Strangely enough, hot coolant will come into contact with oxygen as it is cycled in and out of the overflow bottle. Granted, it takes about 2 years and 40,000km before the customer notices an overheating problem, but this is in a cooling system with a 16-20 liter capacity. Picture a Vmax with it's radiator about the size of a postage stamp (and a coolant capacity of just over 3 liters) and the same amount of blockage in he rad. It's not a pretty thought. Once it's plugged, a manual fan switch or the Borg Warner switch won't help either; it's all about the ability to radiate heat off due to surface area. Plug 1/2 the rad and you have 1/2 the cooling potential. It's also foolish to assume that all that crap is just in the radiator. If the rad is half full of sludge, so is the heart of the cooling system. Now the bike has hot spots and overheating (they always told me in trade school "1/16th of an inch of scale equals the insulating value of 1 inch of cast iron."), and a build up that requires a seriously caustic chemical to remove it. The aluminum of the coolant jackets in the block will not react kindly to the chemical and neither will the radiator or water pump impeller and seal. In addition to this, Dex Cool seems to love to eat brass. We replace a ridiculous amount of block heaters since Dex Cool has been implemented. People talk about green coolant doing damage, this is much, much worse.

I use normal green coolant in my Vmax. I flush it once a year (in the fall), and use distilled water to mix 50/50. Why distilled water? Because it's cheap and tap water has minerals in it. Minerals equal scale buildup (look in or rattle your

kettle). I have had no problems to date (knock on wood), and won't put anything else in until I see some serious proof touting some new coolant. I know that regular maintenance will result in coolant that is not acidic, and still has all of it's additive package intact. This (in theory) should protect the bike from coolant related problems.

----------Dex cool is still a type of Ethylene Glycol. I would be somewhat skeptical of the claims of any new type of product. I have a habit of letting someone else be the Guinea Pig. The products I have passed up so far: Duralube, Slick 50, ZMax, etc. I don't feel like I missed anything major. I have heard through various sources that Low Tox coolant is not nearly as good at heat absorption and transfer as Ethylene Glycol. The Maxes cooling system is so small that I would be very cautious about putting some new solution into it. I still say the best solution is a 50/50 mix of green coolant and distilled water, flushed every fall. I'll say it again: Dex Cool is absolute crap!!!!!!!

----------It is not new and it is not "hear-say." It is green and it is Propylene Glycol. It is in every machine I have. It is much better than Ethylene Glycol at absorbing and dissipating heat.

----------I did some surfing for information on the whole Dex Cool topic. I found that among the other things that are being said about Dex Cool is that it is very poisonous. Apparently, chemicals in this coolant can be absorbed through the skin and are carcinogenic. In addition to this it's flammable. Once again apparently it will flash up at 126 degrees Celsius. The gas produced by this is invisible and odor free but is also cancer-causing.

----------From what I was able to find, Dex Cool is manufactured by AC Delco, Texaco, and it would appear that Prestone is making it also (under another name).

I suspect that GM is using Dex Cool mostly as an advertising tool. It sells cars when a company can say that their vehicle needs no scheduled maintenance other than oil changes, etc for up to 5 yrs. I would be willing to bet that if we had access to the pertinent numbers, we would see that GM sells enough vehicles on that sales premise to offset the warranty costs. In addition, They only have to make the vehicle survive for 3 yrs or 60,000 km (whichever comes first), after that it's either the owner's or an extended warranty company's responsibility. The problem is that the green stuff isn't perfect either. 2 years maximum and then it is typically acidic enough to create voltage in your cooling system. This is an excellent check: take two voltmeter leads and insert them into the coolant in the top of the radiator or overflow bottle. I believe the unwritten spec is .5v maximum. It's quite interesting: coolant starts out just slightly alkali and as it ages, the additive wear out and the coolant begins to become acidic. The definition of a battery is: two dissimilar metals in the presence of an electrolyte (acidic solution). So.....you have acidic coolant (electrolyte) and two dissimilar metals (brass radiator tanks and cores, and aluminum heads, cast iron blocks, etc). You have a battery in your cooling system. This is why I suggest flushing the green stuff out every year. The coolant basically cannot get acidic enough to cause problems in one year.

----------Not to beat the subject to death, but.....the use of distilled water (in conjunction with green coolant) in a system that is flushed regularly, should give excellent results (remember that Yamaha put the green stuff in from the factory).

----------On the Impalla SS group, there has been a lot of discussion on the problems with dex-cool. A survey was done, and all then ones with the rad problems had dex-cool. The same engine with green stuff has no problems. With dex-cool, you find that you have no heat in the winter. Every year you have to flush out your heater core. And the stuff corrodes worse than the green stuff. A lot of users have switched back to green stuff. And the dex-cool gives the same problems if

it is Texaco, GM, Prestone, or Canadian tire.

----------Antifreeze or coolant . Which is best? A Propylene Glycol or a Ethylene Glycol based ? I will say that if you flush your system on a motorcycle every year or 15,000 miles there is no difference in performance of the products . I have yet to see an engineering report that supports the fact that a Propylene Glycol based antifreeze will transfer heat better than a Ethylene Glycol based antifreeze . I mean an independent engineering firm, Govt., or university test . Not statements made by distributors or manufacturers. The biggest reason behind Propylene Glycol based antifreeze is an EPA issue which translates to the cost of recycling & disposal . This comes into focus when considering the military & the trucking or fleet industry logging millions of miles each year . With Propylene Glycol based antifreeze & I emphasize with proper testing procedures & additive level maintenance , you can run it indefinitely reducing the cost of disposal & handling . The only performance gain that I know of is if Propylene Glycol gets into the oil system it will not destroy the crank bearings like Ethylene Glycol will . From a toxicology stand point Propylene Glycol is a lot safer than Ethylene glycol . They are both toxic to humans & animals . It just takes a lot more Propylene Glycol to raise the blood's acid level to become toxic to us . In a nut shell if you are using a Propylene Glycol based antifreeze thinking that it is a superior product to a Ethylene Glycoe Propylene Glycol based antifreeze perform to it's potential you are leading yourself down a path a false security .

----------If you don't need the antifreeze capability, the only reason to use antifreeze is for corrosion suppression. Antifreeze REDUCES thermal transfer vs. water by itself. My recommendation is to use water with Water Wetter or equivalent, and add a can of corrosion inhibitor

----------Well, not so fast. Running an engine "hotter" is not necessarily a bad thing. There's nothing magical about the red zone on the temp gauge - it just tells you when you're nearing the place where water boils, rendering it useless as a coolant. Xxxx may be correct about **localized boiling**/condensing cycles in normal use at "legal" temperatures making for big **localized** hot spots. In theory, preventing that **localized boiling** MAY work to reduce **detonation** etc. It seems to be a trade off with reduced heat transfer for the no-water coolant. It all depends on what you want - a safer motor or a cooler motor. Water transfers heat better and is a more efficient coolant UNTIL IT BOILS. The Xxxx coolant theoretically gives you more protection at the boundary conditions, after water has ceased to work. In any case, there are places in your engine that are a lot hotter than the **boiling** point of water.

----------True, antifreeze stores heat and doesn't release it as well as plain water. Adding Water Wetter will help. Antifreeze stores heat.

----------Does anyone know why Red Line would recommend 'Soft Water', and not distilled water???
----Soft water has the calcium and magnesium replaced with sodium, thus "soft" water. Calcium and magnesium, plus some other metal ions in water tend to precipitate (solidify) out as crud and "gum" and settle into places they should not be, thus "plugging" and reducing flow. Distilled water should be 'softer' that produced by commercial water softeners, right?
---Distilled water tends to have almost all of the metal ions removed by distillation. "**Boiling**" off the water molecules as a gas and reforming them as a liquid leaving almost pure water. Water tends to be a universal solvent, thus chemically attacking or dissolving almost anything to some degree. Around metal ions, such as in a radiator it is quite probable that the ions formed from pure water react to a much higher level chemically because there are more water ions available. Ions are just "electrically" charged parts of atoms or groups of atoms that like to react (attach or bond with other ions) chemically. In hard water and in soft water the ions are chemically bonded more than in pure water. Also there is

concern about galvometric movement of metal ions from one surface to another. Which means metals of different kinds used in a radiator and the entire cooling system including internally in the motor could be replacing one another, eventually causing structural damage.

----------Red line recommends 10% water wetter 20& antifreeze 70% soft water

----------Just my two cents worth; I use soft water in radiators and distilled in batteries. I use tap water in neither. I have no
mechanical reason or background, just concerned about the basic chemistry of water. I tend to use water wetter and about 30% antifreeze, but have absolutely no logic for using water wetter except to attempt to detect if it works. If a bike is sitting in very cold weather the mixture percentage would need to be checked, but many bikes are inside and never exposed to freezing. And a hot bike running in very cold temps is fine with just water in it, of course until a major food or beverage stop:) My experience with the Vmax and V65 both, has been that heat is more easily controlled with a manual fan switch, than anything else I have tired. I have not detected water wetter as being significant for me, but since in theory water wetter breaks down the molecular interface barrier (surface tension) between the liquid water and solid metals, thus allowing improved heat transfer from engine to coolant and from coolant to radiator, it probably is improving cooling to some extent. So Red Lines advice sounds right on the money for me.

---------- Max does ride hot as motorcycles go, but it should not be running hot. Max has a great motor and has a pretty good cooling system. In spite of what anyone says, excessive heat build up in the V-4's can be very serious. Synthetic oil can take the heat but the metals/seals/parts may not. My conclusion is, use synthetic oil and DO worry about extra heat build up, even for just a little while, as chemical/mechanical damage can occur. Keep the rpms up, no excessive idling, no excessive oil changes, as much of the metal to metal contact and wear occurs at idle speeds and oil change times, perhaps 70-90% of total engine wear. Idling produces poor oiling and excessive heat. All of these things are a big no-no for cycle owners. I might add, a healthy cooling system, drained/flushed yearly, with Prestone Extended Life coolant, or a coolant from any of the major cycle brands, which is basically non-silicated extended life coolant, using soft water (not hard tap water because of the precipitation of calcium/ferrous salts producing gumming in the system; not distilled water as it is free of many metallic ions so will "like" or chemically bond with metal ions from the cooling system, which is not good at all). Redline water wetter is used by some, but probably not effective unless used with just water alone, and that is a no-no, as coolant is needed for non-corrosive characteristics. I use water wetter periodically, but cannot detect anything one way or another. A manual fan switch is where it is at.

------Letter To: prestone.information@alliedsignal.com
Subject: Is Prestone Extended Life the same as Dex Cool????
....Stated Fact: Dex-Cool is causing terrible trouble in our radiators, both auto and cycle. I started using Prestone Extended Life in my cycles two years ago, instead of "green stuff." All my vehicles have Extended Life in them. I was under the assumption that Extended Life has none of the metal "eating" similarities of Dex-Cool, nor IS Dex-Cool.
Question: Am I correct that Extended Life and Dex-Cool are two different entities????
….ANSWER BACK FROM PRESTONE: Dexcool and the Extended life are two different formulations made by TEXACO (dex) and PRESTONE (extended), us. The formulations are different. Thanks

------Coolant, thats something not to scrimp on. I use the anti-freeze from Toyota Factory Red. Its 15.00 @ gal. Its used in all their motors, including the Lexus, which has a aluminum motor, radiator, heater core. It doesn't gum up, it has extra rust and corrision inhibiters. When you get some on your hands, it doesn't get sticky as it dries, it stays slippery.

-------You can use coolant you want, provided that it is low silicate or preferably silicate free. It'll say that right on the jug. Aluminum
compatibility is your biggest concern. I use Caterpillar ELC (extended life coolant) It is silicate free and comes pre-diluted 50/50 which I water down (distilled) to 70/30 and add Water Wetter. The Caterpiller stuff is good for 1,000,000 Km! That's 600,000 miles. You can get it at any Caterpillar dealer. I use it, because we use it on our trucks at work.

-------Honda recommends a coolant with no silicates or phosphates. You can use their pre-mix @ $12.00/gal. or you can buy a gallon of Texaco Dex-Cool and a gallon of distilled water and have 2 gallons of coolant for less than $8.00. Yamaha makes no specific recommendations, but I've used the Dex-Cool/distilled water combo successfully for 80,000 miles in my bike. This extended life stuff is good for 5 years or 100,000 miles, but I change it every two years.

--------What I do is drain the old coolant, refill with distilled water, run until hot. Drain and repeat with distilled water. Mix a 50:50 solution of Texaco Havoline Dexcool and distilled water, refill. This is a no silicate/phosphate extended life coolant. Don't touch the thermostat if its operating OK. I change this every two years. 80,000 miles and runs as cool as it ever did. Available at most auto parts stores for around $6.00 a gal. Plus the distilled water ($.79), you get 2 gallons of coolant for around $7.00, more or less.

------I've been thinking of switching over my vehicles to Evans NPG+. Virtually removes the water from the system, and therefore lasts forever... http://www.evanscooling.com

------For those of you who are working with the orange coolant be very careful it is extremely toxic. It cause liver and kidney faliure if even left on skin to long. It is flamable with a flash point of 126.6 Celsius. Do not use unless in well ventelated area or use niosh approved respirator for organic vapors.

------So whats the trade off. All of the mfg. are going to dex cool cause it lasts longer. So it lasts longer it will kill you. What happens when someones heater goes, dex-cool is odorless so your not gonna smell it till your dead. I think they should put a little thought into Safety before putting it in a vehicle. Someone gets in an accident then a fire starts, then toxic gases produced by combusting it form which causes dizzieness and nausea. Then you have other motorist getting sick because of the fumes." On a more serious note, there are many chemicals that mechanics (both professional and backyard) are exposed to on a regular basis. Brake Clean, Var Sol, brake fluid, engine oil, gasoline, paint, paint solvents, engine degreasers, and a whole long list of chemicals that are at the very least carcinogenic. Some are worse. The worst I have heard of is a product called "Viton". It is used in the manufacture of valve seals, gaskets, hoses, and o rings. When burned this stuff produces an acid that has an affinity for calcium. If it is touched with bare hands, it will combine with the water and oil an the skin, be absorbed into the skin, and head for bone. The British Columbia Workers' Compensation board (WCB) sent out warnings suggesting that amputation of the affected area was the best way to ensure that this acid was stopped before it hit the body core. It therefore would not surprise me that Dex Cool produced a noxious gas when burned. Without harping on the safety thing too much, the point to me is to attempt to reduce my exposure to life shortening chemicals. I work in this crap every day , and won't be taking any chances, and if I need to wear a gas mask (which we are already required to do for absestos) to put coolant in a car (just in case), I will do it. I already use latex gloves to stop the chemicals absorbing through my skin.

------The Vmax does ride hot as motorcycles go, but it should not be running hot. Max has a great motor and has a good cooling system. In spite of what anyone says, excessive heat build up in the V-4's can be very serious. The synthetic oil

can take it but the metals/seals/parts may not. Think about using synthetic oil and DO worry about extra heat build up, even for just a little while, as chemical/mechanical things/damage can occur. Keep the rpms up, no excessive idling, no excessive oil changes, as the theory goes, much of the metal to metal contact and wear occurs at idle speeds and oil change times, perhaps 70-90% of total engine wear. Idling produces poor oiling and excessive heat. All of these things are a big no-no. And I might add, a healthy cooling system, drained/flushed yearly, with any good coolant (beware of Dex-Cool, or least study its issues carefully before using). Generally any good quality brand name "green stuff" will work. In the "orange stuff" things like Prestone Extended Life coolant, or coolant from any of the major cycle brands, which are basically non-silicated extended life coolants. I use soft water (not hard tap water because of theprecipitation of calcium/ferrous salts producing gumming in the system; not distilled water as it is free of many metallic ions so will "like" or chemically bond with metal ions from the cooling system, which is not good at all). Redline water wetter is used by some, but probably not effective unless used with just water alone, and that is a no-no, as coolant is needed for non-corrosive characteristics and lubrication qualities. I use water wetter periodically, but cannot detect anything one way or another. A manual fan switch is important during slow riding in warm to hot weather. Changing the thermo switch is okay, but it does not give control over the fan, and that is what is needed.

------Running an engine "hotter" is not necessarily a bad thing. There's nothing magical about the red zone on the temp gauge - it just tells you when you're nearing the place where water boils, rendering it useless as a coolant. Evans may be correct about **localized boiling**/condensing cycles in normal use at "legal" temperatures making for **localized** hot spots. In theory, preventing that **localized boiling** MAY work to reduce **detonation** etc. It seems to be a tradeoff with reduced heat transfer for the no-water coolant. It all depends on what you want - a safer motor or a cooler motor. Water transfers heat better and is a more efficient
coolant UNTIL IT BOILS. The Evans coolant theoretically gives you more protection at the boundary conditions, after water has ceased to work.<<<